



US009410168B2

(12) **United States Patent**
Silverman et al.

(10) **Patent No.:** US 9,410,168 B2
(45) **Date of Patent:** *Aug. 9, 2016

(54) **BIOREFINERY SYSTEM, METHODS AND COMPOSITIONS THEREOF**(71) Applicant: **Calysta, Inc.**, Menlo Park, CA (US)(72) Inventors: **Joshua A. Silverman**, Los Altos Hills, CA (US); **Sol M. Resnick**, Encinitas, CA (US); **Michael Mendez**, San Diego, CA (US); **Renee M. Saville**, Mountain View, CA (US); **Sungwon Lee**, Fremont, CA (US); **Luan Nguyen**, San Ramon, CA (US)(73) Assignee: **Calysta, Inc.**, Menlo Park, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 14/813,804

(22) Filed: Jul. 30, 2015

(65) **Prior Publication Data**

US 2015/0353971 A1 Dec. 10, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/941,027, filed on Jul. 12, 2013, now Pat. No. 9,371,549.

(60) Provisional application No. 61/671,542, filed on Jul. 13, 2012.

(51) **Int. Cl.**

C12P 7/64	(2006.01)
C12N 15/74	(2006.01)
C12P 5/00	(2006.01)
C10L 1/02	(2006.01)
C10L 1/04	(2006.01)
C10G 3/00	(2006.01)
C12N 9/16	(2006.01)
C12N 9/00	(2006.01)
C12N 1/16	(2006.01)
C12N 1/20	(2006.01)
C12N 9/10	(2006.01)
C10G 47/00	(2006.01)

(52) **U.S. Cl.**

CPC .	C12P 7/649	(2013.01);	C10G 3/00	(2013.01);
	C10G 3/50	(2013.01);	C10G 47/00	(2013.01);
	C10L 1/02	(2013.01);	C10L 1/04	(2013.01);
	C12N 1/16	(2013.01);	C12N 1/20	(2013.01);
	C12N 9/1029	(2013.01);	C12N 9/16	(2013.01);
	C12N 9/93	(2013.01);	C12N 15/74	(2013.01);
	C12P 5/00	(2013.01);	C12P 7/6409	(2013.01);
	C12P 7/6463	(2013.01);	C12Y 301/02	(2013.01);
	C12Y 602/01003	(2013.01);	C10G 2300/1014	(2013.01);
			C10L 2200/0469	(2013.01);
			C10L 2270/02	(2013.01);
			C10L 2270/04	(2013.01);
			C10L 2290/26	(2013.01);
			C12Y 203/01039	(2013.01);
			C12Y 604/01002	

(2013.01); **Y02E 50/13** (2013.01); **Y02E 50/343** (2013.01); **Y02P 20/52** (2015.11); **Y02P 30/20** (2015.11)(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,269,940 A *	5/1981	Patel	C07D 301/02
			435/148
6,492,135 B1	12/2002	Larsen	
6,689,601 B2	2/2004	Koffas et al.	
6,818,424 B2	11/2004	DiCosimo et al.	
7,026,464 B2	4/2006	Dicosimo et al.	
7,098,005 B2	8/2006	Dicosimo et al.	
7,579,163 B2	8/2009	Eriksen et al.	
7,799,550 B2	9/2010	Moen et al.	
8,062,392 B2	11/2011	Bryan et al.	
8,093,306 B2	1/2012	Blevins et al.	
8,129,154 B2	3/2012	Burk et al.	
8,129,155 B2	3/2012	Trawick et al.	
8,153,850 B2	4/2012	Hall et al.	
8,168,686 B2	5/2012	Blevins et al.	
8,173,044 B1	5/2012	Cheiky et al.	
8,177,870 B2	5/2012	Herrema et al.	
8,592,198 B2	11/2013	Moen et al.	
2003/0003528 A1	1/2003	Brzostowicz et al.	
2005/0054030 A1	3/2005	Schnoor et al.	
2005/0163802 A1	7/2005	Jorgensen et al.	
2006/0057726 A1	3/2006	Sharpe	
2008/0026005 A1	1/2008	Miguez et al.	
2008/0057554 A1	3/2008	Huhnke et al.	
2009/0263877 A1	10/2009	Eriksen et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 296 484 A2	12/1988
EP	1 265 982 B1	9/2004

(Continued)

OTHER PUBLICATIONS

Stein LY et al. Genome sequence of obligate methanotroph Methylosinus trichosporium strain OB3b. 2010. Journal of Bacteriology. vol. 192, No. 24. p. 6497-6498.*

Henstra et al., "Microbiology of synthesis gas fermentation for biofuel production," Current Opinion in Biotechnology 18:200-206 (2007).

Jahnke, "The effects of growth temperature on the methyl sterol and phospholipid fatty acid composition of *Methylococcus capsulatus* (Bath)," FEMS Microbiology Letters 93:209-212 (1992).

(Continued)

Primary Examiner — Paul Holland

(74) Attorney, Agent, or Firm — Seed IP Law Group PLLC

(57) **ABSTRACT**The present disclosure relates to bioengineering approaches for producing biofuel and, in particular, to the use of a C₁ metabolizing microorganism reactor system for converting C₁ substrates, such as methane or methanol, into biomass and subsequently into biofuels, bioplastics, or the like.